NCMA TEK

National Concrete Masonry Association
an information series from the national authority on concrete masonry technology

CONTROL JOINTS FOR CONCRETE MASONRY WALLS - EMPIRICAL METHOD

TEK 10-2B
Movement Control (2005)

Keywords: bond beams, construction details, control joints, crack control, joint reinforcement, reinforcing bars, reinforced concrete masonry, shrinkage, wall movement

INTRODUCTION

Concrete masonry is a popular construction material because its inherent attributes satisfy the diverse needs of both exterior and interior walls. While these attributes are the primary basis for concrete masonry's popularity, performance should not be taken for granted. Like all construction systems, design decisions significantly influence field performance of the concrete masonry wall system. Proper application of crack control measures, including control joints when required, can help ensure satisfactory performance of the concrete masonry.

Control joints are one method used to relieve horizontal tensile stresses due to shrinkage of the concrete masonry units, mortar, and when used, grout. They are essentially vertical separations built into the wall at locations where stress concentrations may occur. These joints reduce restraint and permit longitudinal movement.

Control joints are typically only required in exposed concrete masonry walls, where shrinkage cracking may detract from the appearance of the wall. Shrinkage cracks in concrete masonry are an aesthetic, rather than a structural, concern. In addition, walls with adequate horizontal reinforcement may not require control joints, as the reinforcement effectively reduces the width of shrinkage cracks. Foundation walls traditionally do not include control joints due to concerns with waterproofing the joint to withstand hydrostatic pressure. Additionally, since foundation walls are subjected to relatively constant temperature and moisture conditions, shrinkage cracking in below grade walls tends to be less significant than in above grade walls.

This TEK focuses on cracking resulting from internal volume change of the concrete masonry. Potential cracking resulting from externally applied design loads due to wind, soil pressure, seismic forces, or differential settlement of foundations is controlled by limiting the design stress in allowable stress design or by providing adequate strength when strength design is used. These design considerations are not covered here. Where external loads are an issue in combination with internal volume change, the design should consider the combined effects of these influences on cracking.

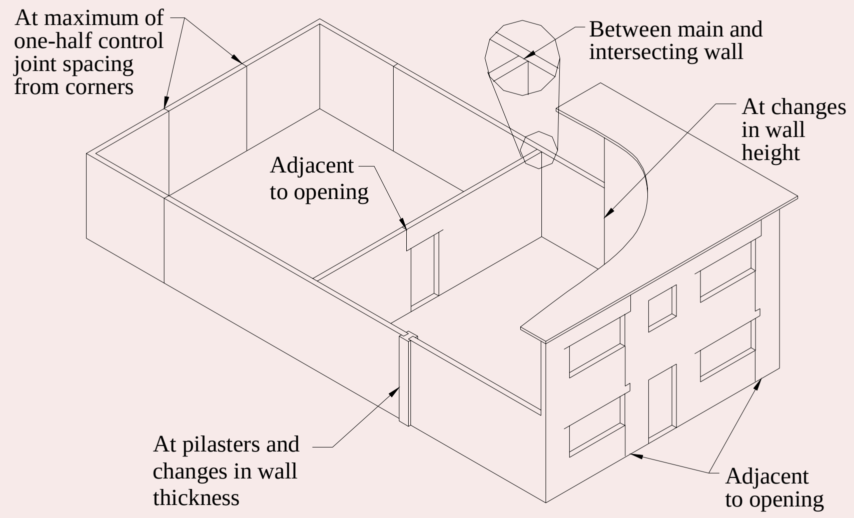

Figure 1—Typical Control Joint Locations

Table 1—Recommended Control Joint Spacing for Above Grade Exposed Concrete Masonry Walls[a]

Distance between joints should not exceed the lesser of:

Length to height ratio	or ft (m)
1½	25 (7.62)

[a]Notes:

1. Table values are based on the use of horizontal reinforcement having an equivalent area of not less than 0.025 in.^{2}/ft (52.9 mm^2/m) of height to keep unplanned cracks closed (see Table 2).
2. Criteria applies to all concrete masonry units.
3. This criteria is based on experience over a wide geographical area. Control joint spacing should be adjusted up or down where local experience justifies but no farther than 25 ft (7.62 m).

Table 2—Maximum Spacing of Horizontal Reinforcement to Achieve 0.025 in.^{2}/ft (52.9 mm^2/m) Criteria

Reinforcement size	Maximum spacing, in. (mm)
2[a] x W1.7 (9gage)(MW11)	16 (406)
2[a] x W2.1 (8gage)(MW13)	16 (406)
2[a] x W2.8 (3/16 in.)(MW18)	24 (610)
4[b] x W1.7 (9gage)(MW11)	32 (813)
4[b] x W2.1 (8gage)(MW13)	40 (1016)
4[b] x W2.8 (3/16 in.)(MW18)	48 (1219)
No. 3 (M#10)	48 (1219)
No. 4 (M#13)	96 (2348)
No. 5 (M#16) or larger	144 (3658)

Notes:
a. Indicates 2 wires per course, one in each faceshell.
b. Indicates 4 wires per course, two in each faceshell.

CONTROL JOINT PLACEMENT

When required, control joints should be located where volume changes in the masonry due to drying shrinkage, carbonation, or temperature changes are likely to create tension in the masonry that will exceed its capacity. In practice, this can be difficult to determine, but several methods are presented in the following sections to provide guidance in locating control joints.

In addition, care should be taken to provide joints at locations of stress concentrations such as (see Figure 1):

1. at changes in wall height,
2. at changes in wall thickness, such as at pipe and duct chases and pilasters,
3. at (above) movement joints in foundations and floors,
4. at (below) movement joints in roofs and floors that bear on a wall,
5. near one or both sides of door and window openings, (Generally, a control joint is placed at one side of an opening less than 6 ft (1.83 m) wide and at both jambs of openings over 6 ft (1.83 m) wide. Control joints can be away from the opening if adequate tensile reinforcement is placed above, below, and beside wall openings.)
6. adjacent to corners of walls or intersections within a distance equal to half the control joint spacing.

EMPIRICAL CRACK CONTROL CRITERIA

For walls without openings or other points of stress concentration, control joints are used to effectively divide a wall into a series of isolated panels. Table 1 lists recommended maximum spacing of these control joints based on empirical criteria. This criteria has been developed based on successful, historical performance over many years in various geographical conditions. The empirical method is the most commonly used method and is applicable to most building types. An engineered method is presented in TEK 10-3 *Control Joints for Concrete Masonry walls - Alternative Engineered Method* (ref. 1). It is generally used only when unusual conditions are encountered such as dark colored units in climates with large temperature changes.

The provisions in this TEK assume that units used in the construction comply with the minimum requirements of ASTM C 90 *Standard Specification for Loadbearing Concrete Masonry Units* (ref. 2) and that a minimum amount of horizontal reinforcement is provided as indicated in Footnote 1 of Table 1. It is intended to provide the most straightforward guidelines for those cases where detailed properties of the concrete masonry are not known at the time of design. As indicated in Footnote 3 of Table 1, local experience may justify an adjustment to the control joint spacings presented in the table.

To illustrate these criteria, consider a 20 ft (6.10 m) tall warehouse with walls 100 ft (30.48 m) long. Table 1 indicates control joints spaced every 25 ft (7.62 m). In this example, the maximum spacing of 25 ft (7.62 m) governs over the maximum length to height ratio of 1½ times 20 ft (6.10 m) or 30 ft (9.14 m). For walls containing masonry parapets, consider the parapet as part of the masonry wall below if it is connected by masonry materials such as a bond beam unit when determining the length to height ratio.

The control joint spacings of Table 1 have been developed based on the use of horizontal reinforcement to keep unplanned cracks closed as indicated in Footnote 3. The minimum area of reinforcement given, 0.025 in.^{2}/ft (52.9 mm^2/m) of height, translates to horizontal joint reinforcement spaced as indicated in Table 2.

CONSTRUCTION

Common control joints are illustrated in Figure 2. The joints permit free longitudinal movement, but may need to transfer lateral or out-of-plane shear loads. These loads can be transferred by providing a shear key, as shown in Figure 2a, 2d and 2f. Figure 2e shows smooth dowel bars placed across the control joint to transfer shear. The dowels are typically greased or placed in a plastic sleeve to reduce bond and allow

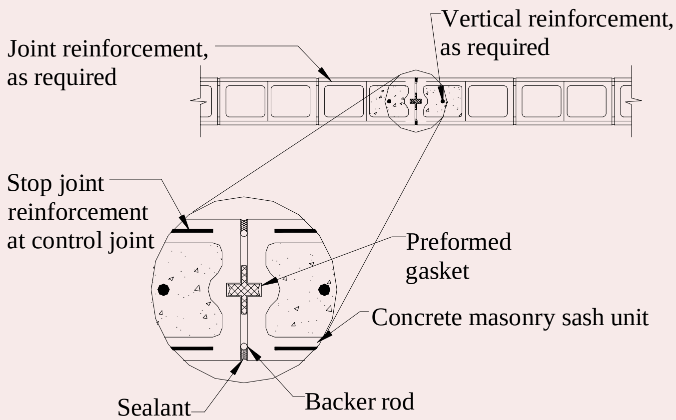

Figure 2a—Preformed Gasket

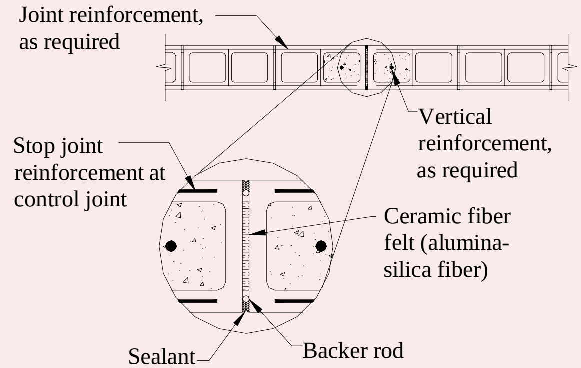

Figure 2b—4 Hour Fire Rated Control Joint

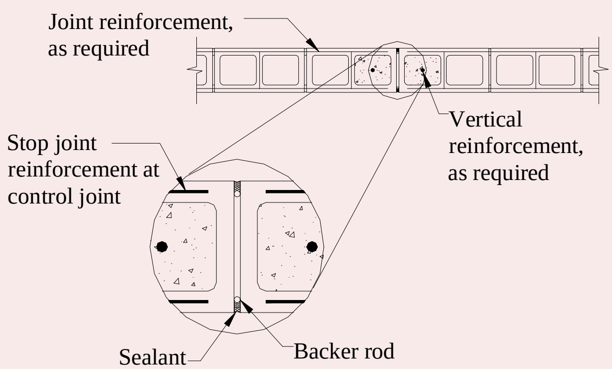

Figure 2c—Discontinuous Horizontal Reinforcement

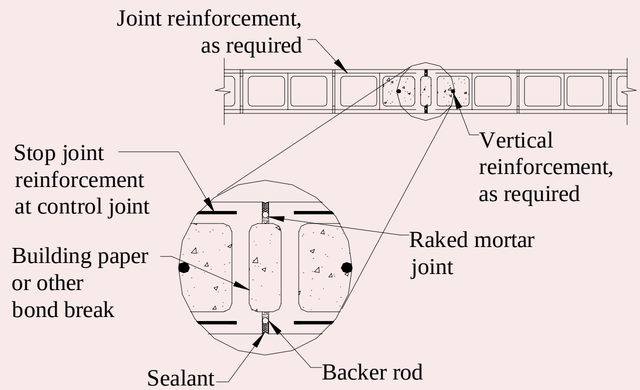

Figure 2d—Formed Paper Joint

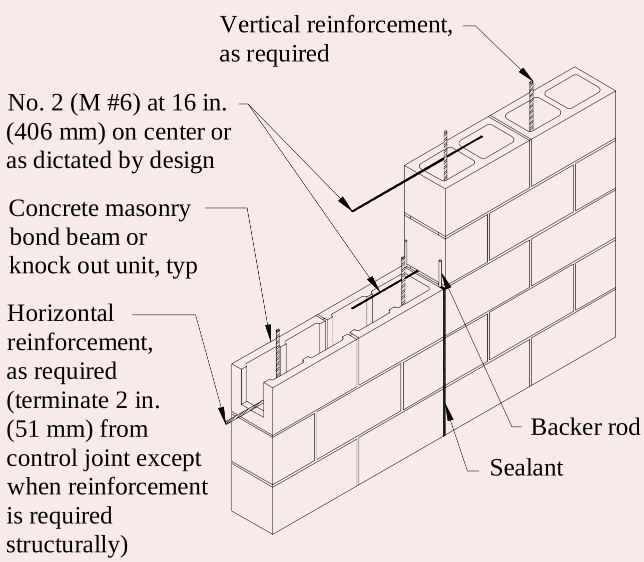

Figure 2e—Doweled Joint (for Shear Transfer)

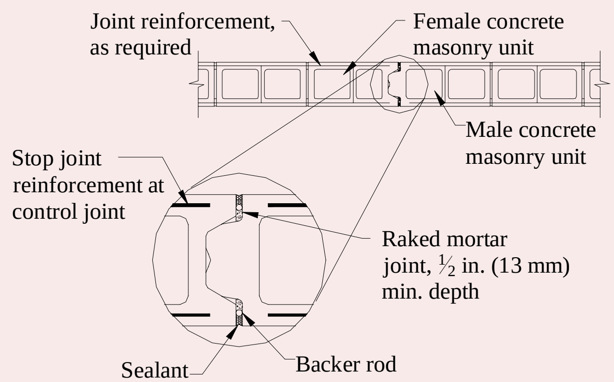

Figure 2f—Special Shaped Units

Figure 2—Typical Control Joint Details

the wall to move longitudinally. Control joints also must be weather-tight when located in exterior walls.

Nonstructural reinforcement, such as horizontal joint reinforcement which is mostly used for crack control only, should not be continuous through a control joint, since this will restrict horizontal movement. However, structural reinforcement, such as bond beam reinforcement at floor and roof diaphragms that resists diaphragm cord tension, must be continuous through the control joint.

Where concrete masonry is used as a backup for other materials, consider the following:

1. control joints should extend through the facing when wythes are rigidly bonded,
2. control joints need not extend through the facing when bond is flexible (i.e. metal ties). However, depending on the type of facing, considerations should be given to crack control in the facing material as well.

For example, control joints should extend through plaster applied directly to masonry units. Plaster applied on lath which is furred out from masonry may not, however, require vertical separation at control joints.

REFERENCES

1. *Control Joints for Concrete Masonry Walls - Alternative Engineered Method*, TEK 10-3. National Concrete Masonry Association, 2003.
2. *Standard Specifications for Loadbearing Concrete Masonry Units*, ASTM C 90-03. ASTM International, 2003.

NATIONAL CONCRETE MASONRY ASSOCIATION
13750 Sunrise Valley Drive, Herndon, Virginia 20171
www.ncma.org

To order a complete TEK Manual or TEK Index, contact NCMA Publications (703) 713-1900